

# Boardworks GCSE Science: Chemistry

## Earth's Structure

**GCSE Science**

### Earth's Structure

1 of 41

### Earth's Structure

**Contents**

- The structure of the Earth
- Plate tectonics
- Volcanoes and volcanic rock
- Living with an active Earth
- Summary activities

2 of 41

### How has the Earth changed?

#### History of the Earth

The age of the Earth, and the rest of the Solar System, is generally accepted to be **4,600 million years!**

Click each date in the timeline below to find out about events in the history of Earth.

4600 3700 1900 500 230 200 65 3.5 0.2 0.005 0.00015

millions of years ago

3 of 41

### What is the Earth made from?

If it was possible to dig to the centre of the Earth, what would you find?

You would dig through three sections:

- crust** – the rocky, outer layer beneath your feet.
- mantle** – the semi-liquid, very high temperature layer below the crust. The cooler section near to the crust is less mobile than the hotter section next to the core (known as the asthenosphere).
- core** – the layer at the centre of the Earth. This layer is divided into two sections: the liquid, **outer core** and the solid, **inner core**.

4 of 41

### Cross-section of the Earth

#### What are the layers of the Earth?

This cross-section of the Earth shows that it is made up of four different layers.

Each layer has its own distinctive properties, including thickness and temperature.

Click on each layer below to find out about more about the structure of the Earth.

crust mantle outer core inner core

5 of 41

### Earth's Structure

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6 of 41

# Boardworks GCSE Science: Chemistry

## Earth's Structure

### How does the Earth's surface change?

The shapes and positions of the continents make up a very familiar image.



The Earth's surface is a very dynamic place and has not always looked like this.


Earthquakes, volcanic activity and other phenomena have been changing the face of the planet for millions of years.

The key geological theory that explains how the Earth's surface changes now and has changed in the past is called **plate tectonics**.

So what exactly is the theory of plate tectonics and how was it developed?

### Introducing plate tectonics

#### What is plate tectonics?




Imagine that land on the Earth's surface is like bread floating on a pan of soup (the mantle).


Click "play" to see how the Earth's surface changes due to plate tectonics.

### Have the continents moved?

**Alfred Wegener** was a key figure in changing ideas about the Earth's surface. In 1912, he proposed that all the continents were once joined in a single supercontinent, called **Pangaea**.



Wegener suggested that Pangaea began to break up about 200 million years ago and the pieces drifted apart to form the present day continents.




At the time, Wegener's theory of '**continental drift**' was dismissed by geologists because he could not provide a convincing explanation for how the continents were able to move.

### How was Wegener's theory developed?

#### Developing the theory of continental drift

The theory of continental drift was developed over time due to the combined efforts of many of pioneering scientists.




The theory had to battle against many criticisms, but ultimately became one of the great milestones in our understanding of the Earth's structure.

Click "start" to find out about the development of this theory.

### How have the continents changed?

#### What is continental drift?



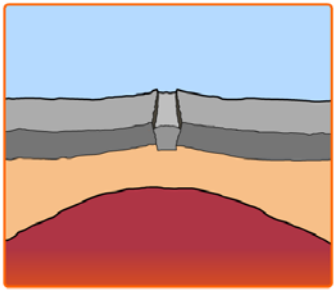
According to the theory of continental drift, the positions of the continents on the Earth's surface have changed over time.

Click "start" to find out more about this.

### What is seafloor spreading?

#### What is seafloor spreading?

Seafloor spreading was proposed by **Harry Hess** to explain continental drift.



In seafloor spreading, two oceanic plates move away from each other resulting in the formation new oceanic crust.

Click "start" to find out more about this process.

# Boardworks GCSE Science: Chemistry

## Earth's Structure

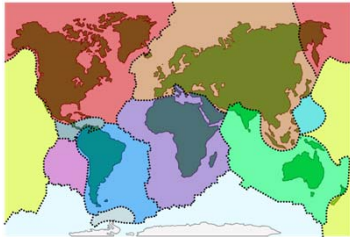
### What is the theory of plate tectonics?

The explanation for how the continents move came from observations of seafloor spreading and other effects. In 1967, these ideas were linked in the **theory of plate tectonics**.

According to this theory, the Earth's crust is like a jigsaw puzzle made up of giant sections called **tectonic plates**.

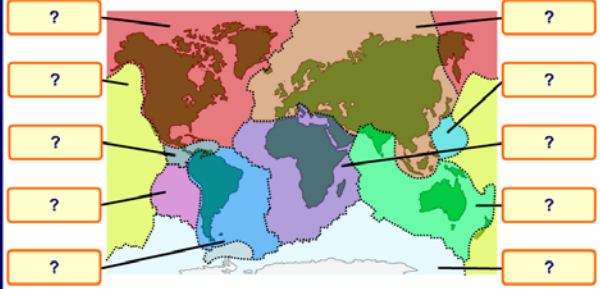
These plates 'float' on top of the mantle and so can move around the Earth's surface.

There are 10 major tectonic plates and several minor plates.



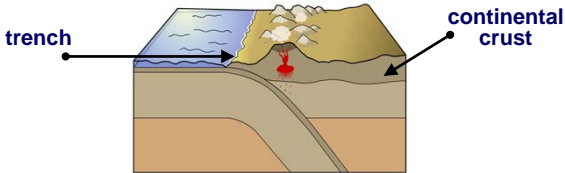
### What are the major tectonic plates?

What are the names of the major tectonic plates?



### What is a plate boundary?

The area where two tectonic plates meet is called a **plate boundary**. Mountains, volcanoes and oceanic trenches are formed at plate boundaries, and earthquakes are more likely to occur here.



trench

continental crust


There are three types of plate boundary: **constructive**, **destructive** and **conservative**. Each type is characterized by how the plates and the geological effects of this movement.

### Identifying plate boundaries

What are the different types of tectonic plate boundary?

There are three different types of plate boundary. Each one is characterized by the movement of the plates and how this affects the Earth's surface.

Click on each type of plate boundary to find out more about its movement.




constructive destructive conservative

### Effects of tectonic plate movements

What are the effects of tectonic plate movements?

The movement of tectonic plates has dramatic effects on the Earth's surface at the plate boundaries.



Click on each type of plate boundary below to find out what happens to the Earth's surface at each one.

constructive destructive conservative


### How do tectonic plates move?

How do convection currents move tectonic plates?

Heat generated in the Earth's core causes the tectonic plates on the Earth's surface to move.

This process occurs due to the formation of convection currents in the mantle.

Click "start" to find out how this takes place.



start

# Boardworks GCSE Science: Chemistry

## Earth's Structure

### Plate tectonics – true or false?

Are these statements about Earth's surface true or false?

1. The rocky outer layer of the Earth is called the crust.	
2. The core is the layer of slightly mobile rock beneath the crust.	
3. The inner core is the hottest area of the Earth and is mainly composed of solid iron.	
4. Einstein proposed the theory of continental drift.	
5. Pangaea is the supercontinent that existed before the continents drifted apart.	
6. Plate tectonics is the theory of shifting plates that explains continental drift.	

### Key points about plate tectonics

The theory of plate tectonics explains the movement of, and changes to, the Earth's crust. The key points are:

- The Earth's surface is made up of several huge tectonic plates (like pieces of a jigsaw puzzle) that are continually moving.
- The ocean floors are continually moving, spreading from the centre and sinking at the edges.
- Earthquakes and volcanoes occur at plate boundaries, where the tectonic plates meet.
- Convection currents in the mantle move the tectonic plates on the Earth's surface. The source of the heat driving the convection currents is radioactive decay deep within the Earth's core.

### Earth's Structure

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### Where do rocks come from?

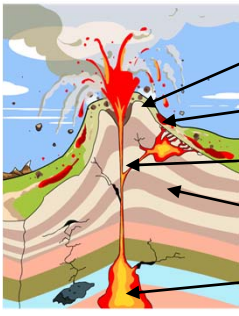
#### How are rocks formed?

How are igneous, sedimentary and metamorphic rocks formed?

Click "play" to find out more about these rocks.

### How are volcanoes formed?

Volcanoes form where molten rock (**magma**) from the mantle pushes upwards through weaknesses in the Earth's surface. Magma that reaches the surface is known as **lava**.



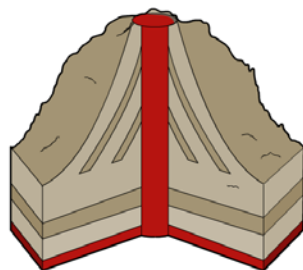
- crater
- lava
- central vent
- strata (layers)
- magma chamber

### Classifying volcanoes types

#### What are the common types of volcano?

You might be surprised to learn that geologists have identified at least 26 different types of volcano. Some types of volcano are easy to recognize and some are not.

Click "start" to find out about the characteristic features of the three most common types of volcano.



# Boardworks GCSE Science: Chemistry

## Earth's Structure

### What happens when magma cools?

As magma from the Earth's mantle cools, it solidifies and crystallizes to form igneous rocks. **Granite, basalt** and **obsidian** are examples of igneous rocks.

Rocks formed when expelled lava cools on the Earth's surface are called **extrusive** igneous rocks.

When magma cools below the Earth's surface, **intrusive** igneous rocks are formed.

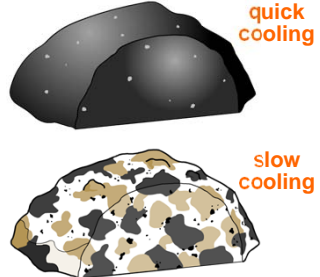


### How does cooling affect crystal size?

Magma is full of minerals that turn into crystals under the right conditions. The size of the crystals in an igneous rock is related to the rate at which the molten magma cools.


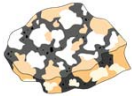


If magma cools **quickly**, the crystals do not have very much time to form and so are **small** in size. **Basalt** has small crystals.

On the other hand, if magma cools **slowly**, the crystals have more time to grow and so are **large**. **Granite** has large crystals.



### How are different igneous rocks formed?

Are these igneous rocks formed by quick or slow cooling?

	<b>rhyolite</b>	<b>granite</b>
<b>Rocks from low-silica lava</b>		
	<b>quick cooling</b>	<b>slow cooling</b>
<b>Rocks from high-silica lava</b>	<b>basalt</b>	<b>gabbro</b>
		
	<b>quick cooling</b>	<b>slow cooling</b>

### Earth's Structure

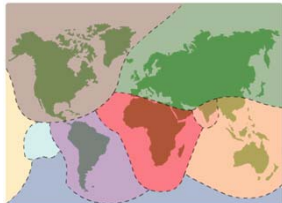
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### Are tectonic plates dangerous?

Although tectonic plates move very slowly, they can have devastating effects when plate boundaries are very active.

Which hazardous geological phenomena are more common near plate boundaries?



- earthquakes
- tsunamis (triggered by underwater earthquakes)
- volcanic eruptions
- lahars (mud slides caused by lava melting snow)
- geysers (geothermal vents)
- sulfur dioxide gas


### Can earthquakes be predicted?

In the past, only a handful of earthquakes have ever been accurately predicted. However, as technology improves, scientists are becoming more accurate in their predictions, which are based on a number of indicators.

In 1975, the population of the Chinese city of Haicheng were successfully evacuated the day before a major earthquake.

This occurred after scientists observed changes in:

- tectonic plate activity
- land elevation
- unusual animal behaviour.



# Boardworks GCSE Science: Chemistry

## Earth's Structure


### Can eruptions be predicted?


**How can volcanic eruptions be predicted?**


Volcanic eruptions can be a huge threat to humans.


Scientists use a number of different indicators to try and predict when a volcano might erupt.

Click on each factor below to find how it can be used in predicting eruptions.

  
**volcano shape**

  
**water levels**

  
**earthquakes**

  
**emissions**

### Why are predictions hard to make?

Scientists who study volcanoes are called **volcanologists**.

They are skilled at monitoring the changes in active volcanoes that can indicate when an eruption might occur.

Monitoring equipment is very expensive and there are not enough resources to keep check of every active site in the world.

This means that volcanologists cannot always pinpoint exactly when an eruption may happen.




### Can volcanoes have benefits?

Volcanoes can be extremely destructive but they are also a creative force.

When volcanic lava cools and solidifies, new land mass is created.

The lava is weathered and breaks down into a fine soil, which is often very fertile.

Volcanoes also produce and transport igneous rocks, which are useful building materials.

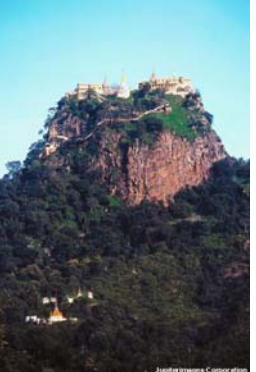


### Why do people live at plate boundaries?


Many people chose to live in areas where earthquakes or volcanic eruptions are a threat, despite the risks involved.

Why might people do this?

- The soil is often more fertile.
- The area attracts tourists.
- Power is easily obtained from geothermal vents.
- Their culture or religion is based around the area and they do not want to leave.



### How can geothermal energy be used?



Iceland sits on the boundary of the mid-Atlantic tectonic plates.

A plate boundary is not always a peaceful place, but its location does provide an endless supply of energy.

Icelanders use hot water directly from the Earth to heat their homes and businesses.

The hot water is stored in huge tanks on one of Reykjavik's few hills. Gravity is then used to distribute the water to the city.

### Geothermal energy

**What are the advantages and disadvantages of geothermal energy?**

Advantages	Disadvantages

Threat of cheaper resources from abroad.

**C solve**

# Boardworks GCSE Science: Chemistry

## Earth's Structure

### Earth's Structure

**Contents**

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### Glossary (1/2)

- continental drift** – The theory that the continents were once all joined together and have slowly moved apart over millions of years.
- convection currents** – Circular currents in the mantle created by the rising of hot magma and sinking of cool magma. These currents cause tectonic plates to move.
- crust** – The thin, rocky, outer layer of the Earth.
- igneous rock** – The type of rock formed when magma cools and solidifies.
- inner core** – The solid, central region of the Earth, which is mostly made of iron and nickel.
- mantle** – The thick layer of the Earth made of very hot, dense, flowing rock. It is between the crust and the outer core.

### Glossary (2/2)

- outer core** – The molten layer of the Earth that surrounds the inner core and is mostly made of iron and nickel.
- Pangaea** – The supercontinent made up of all the Earth's land masses, which existed about 200 million years ago.
- plate boundary** – An area where tectonic plates meet and interact, which affects the Earth's surface.
- plate tectonics** – The theory that the Earth's surface is made up of huge sections that are continually moving.
- seafloor spreading** – The movement of two oceanic plates away from each other, which results in the formation of new oceanic crust and a mid-ocean ridge.
- tectonic plate** – One of the huge sections of the Earth's surface that moves slowly over the mantle.

### Anagrams

How quickly can you unscramble anagrams of words about

**E a r t h ' s**  
**s t r u c t u r e ?**

start

### Multiple-choice quiz

Take this quiz to test the boundaries of your knowledge of the Earth's structure.

start